EFFECT OF ELECTRODE DISTANCE IN ELECTROCOAGULATION PROCESS TO TREAT RESTAURANT WASTEWATER

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SUPERVISOR'S DECLARATION

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I hereby declare that the work in this thesis is my own except for quotations and summaries in which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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ABSTRACT

Electrocoagulation treatment process (EC) is an effective ttreatment process that applying an electric current to enhance the oxidation and reduction take place.This project is all about the effect of operating parameters on restaurant wastewater treatment by using electrocoagulation method. In general, wastewater is all the dirty water comes from main sources either schools, restaurants, commercial establishments, hospitals, farms and factory that usually flow down enters storm drainage system. Oily and greasy wastewater from restaurant or canteen cannot be collected and discharged to municipal drainages system directly because of faultiness of the existing wastewater treatment system. Thus, in this project, the treatment of restaurant wastewater by investigate, and measure by testing the level of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS). In this project, only one of the three main operating parameters have been investigated and come out with the results. The operating parameter that involve is the effect of electrode distance on restaurant wastewater treatment by electrocoagulation process has been successfully observed and investigated.

ABSTRAK

Proses rawatan Elektrokoagulasi adalah proses rawatan yang berkesan menggunakan arus elektrik untuk meningkatkan pengoksidaan dan pengurangan berlaku. Projek ini berkenaan kesan parameter pengendalian ke atas rawatan sisa buangan restoran dengan mengunakan kaedah elektrokoagulasi. Secara umum, sisa buangan adalah semua air kotor yang datang dari sumber utama samaada sekolah, restoran, penubuhan komersial, hospital, ladang dan kilang yang mengalir melalui sistem perparitan. Sisa buangan dari kantin atau restoran yang berminyak dan bergris tidak boleh dikumpul dan disalirkan terus kepada sistem pengaliran kerana kekotoran yang terdapat pada sisa buangan tersebut. Jadi, dalam projek ini, rawatan sisa buangan restoran diuji dan diukur dengan menguji aras Keperluan Oksigen Biokimia, Keperluan Oksigen Kimia, dan Jumlah Pepejal Terampai. Dalam projek ini, hanya tiga parameter yang akan dikaji dan mengeluarkan keputusan. Pengendalian parameter yang terlibat adalah kesan jarak elektrod terhadap rawatan sisa buangan restoran mengunakan elektrokoagulasi proses telah berjaya dikaji dan diuji.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

A	Ampere
T	Time
M	Molecular Weight
Z	Electron Involved
°C	Degree Celsius
e^-	Electron
G	Gram
H^+.	Hydrogen ion
F	Faradays Constant
L	Liter
H	Hour
Mg	Milligram
mg/L	Milligram per Liter
$Fe_3{}^+$	Iron ion
$Al_3{}^+$	Aluminum ion
Alum	Aluminum sulfate
mL	Milliliter
Mm	Millimeter
Min	Minute
$FeCl_3$	Ferric Chloride
Fe_2SO_4	Ferrous Sulfate
Al	Aluminum
H_2	Hydrogen gas
pH	Potential of Hydrogen
A	Weight of filter + dried residue
B	Weight of filter
DO_i	Dissolved oxygen initial
DO_f	Dissolved oxygen final

LIST OF ABBREVIATIONS

COD	Chemical Oxygen Demand
TSS	Total Suspended Solid
BOD	Biochemical Oxygen Demand
TDS	Total Dissolved Solid
EC	Electrocoagulation
DC	Direct Current
DNA	Deoxyribonucleic acid
AC	Alternating Current
V	Voltage
PAC	Polialuminum chloride
E. coli	Escherichia coli
ULR	Ultra Long Range
HCL	Hydrochloric Acid

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

The most important substances on Earth are water. Human being, animal and all plants use water to survive. It is obvious that there will be no life on Earth without the existence of water. It is essential that water, which people use is clean water. Water that is safe for drinking is called potable water and water that is not safe for drinking is said to be non-potable water. The population in Malaysia is increasing rapidly and its places more pressure on the environment and threatening sources of fresh water supplies. It is identified that the problem from food section such as restaurant wastewater needed proper management. Moreover, thousands of people have died because of polluted water supply. This situation has lead people to take all actions for the wastewater treatment.

People are not concern on restaurant wastewater as they busy finding a profit for their business. The common factor that need to be considered before discharge the wastewater are Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) andTotal Suspended Solid (TSS). Various methods for treatment process had been introduced to meet the need to protect public health and environment. Electrocoagulation is one of the good methods to treat restaurant wastewater. This project only focused on how to use the electrocoagulation process (EC) contribute effective effect when applying to treat the restaurant wastewater by using certain operating parameters.

1.2 RESTAURANT WASTEWATER IN MALAYSIA

Wastewater is anything from water that flows down the sink or toilet that enters storm drainage systems. In simple terms, wastewater is all the dirty water from municipal sources (poop, urine and faecal sludge). This includes black water, gray water and yellow water. All dirty water from all the schools, restaurants, commercial establishments, hospitals, farms, and floodwater is considered wastewater. Some wastewater contain hazardous dissolved toxins and chemicals, whiles others contain particles, sediments and suspended matter of all sizes.

Wastewater treatment processes remove a variety of contaminants from water to make it usable again. The benefits of such treatment depend on the nature of the contaminants in the water and the end use of the water treated (Dooley, 2008). In the context of Malaysia, there are many restaurants and fast-food shops that use over half a million tons of water every day. The direct discharge of wastewater from these restaurants and shops down the drain is a huge extra burden to the municipal wastewater collection and treatment works. The oil and grease contained in the wastewater aggregate and foul the sewer system and generate an unpleasant odor. Besides that, there must be highly efficient of facilities in restaurant wastewater for removing of oil and grease, cause no food contamination, and be compact in size.

1.3 WASTEWATER TREATMENT

To measure how effective the Electrocoagulation treatment, the following inputs or variables in the wastewater type, pH, current density, type of metal electrodes(aluminum, steel, iron), number of electrodes, size of electrodes, and also the configuration of metals must be considered (Hossain, Mahmud, Parvez, & Cho, 2013). These variables can leave obvious impact upon the overall treatment time, and also the removal efficiency measured.

Electrocoagulation is an alternative method to classic chemical coagulation for many reasons. With Electrocoagulation treatment, the usage of chemical consumed in treatment is reduced significantly as the metal electrodes itself supply the coagulant. But still, there are some individuals still applying extra chemical coagulants to speed up or

enhance their treatment process. Depending on the volume of water treated, chemical coagulation involves the usage of alum (aluminum sulfate), ferric chloride ($FeCl_3$), or ferrous sulfate (Fe_2SO_4) which can be very expensive (Parmar, Prajapati, Patel, & Dabhi, 2011). After doping the chemical coagulant, the coagulants act as a similar role as the metal electrodes, neutralizing the charge of the particulates, thereby allow them to agglomerate and sink down at the bottom of the tank. Furthermore, electrocoagulation is also capable of reducing waste production from wastewater treatment and also reduces the time necessary for treatment (Butler *et al*., 2011).

Studied was shown that the electrocoagulation process could achieve high COD removal. However, suspended solids and color removal was not conducive for secondary sewage treatment. Nevertheless, small scale decentralized restaurant wastewater treatment is still archivable via electrocoagulation (Iswanto *et al.*, 2013). Among most of the wastewater treatment available across market, coagulation is one of the most important physio-chemical reactions used in water treatment. Ions (heavy metals) and colloids (organic and inorganic) are mostly held in solution by electrical charges. The addition of ions with opposite charges destabilizes the colloids, allowing them to coagulate. Coagulation can be achieved by a chemical coagulant or by electrical methods. The mechanism of coagulation has been the subject of continual review. It is generally accepted that coagulation is brought about primarily by the reduction of the net surface charge to a point where the colloidal particles, previously stabilized by electrostatic repulsion, can approach closely enough for van der Waals forces to hold them together and allow aggregation (Vong & Garey, 2014). The reduction of the surface charge is a consequence of the decrease of the repulsive potential of the electrical double layer by the presence of an electrolyte having opposite charge. In the Electrocoagulation process, the coagulant is generated in situ by electrolytic oxidation of an appropriate anode material. In this process, charged ionic species—metals or otherwise—are removed from wastewater by allowing it to react with an ion having an opposite charge, or with metallic hydroxides generated within the effluent.

Electrocoagulation offers an alternative to the use of metal salts or polymers and polyelectrolyte addition for breaking stable emulsions and suspensions. The technology removes metals, colloidal solids and particles, and soluble inorganic pollutants from

REFERENCES

Adhoum, N., Monser, L., Bellakhal, N., & Belgaied, J. E. (2004). Treatment of electroplating wastewater containing Cu2+, Zn2+and Cr(VI) by electrocoagulation. *Journal of Hazardous Materials*, *112*(3), 207–213. https://doi.org/10.1016/j.jhazmat.2004.04.018

Akbal, F., & Camci, S. (2010). Comparison of electrocoagulation and chemical coagulation for heavy metal removal. *Chemical Engineering and Technology*, *33*(10), 1655–1664. https://doi.org/10.1002/ceat.201000091

Al-rubaiey, N. A., & Al-barazanjy, M. G. (2017). Study the Efficiency of Electrocoagulation System Using Conductivity Measurements for the Removal of Zinc Heavy Metal, 42–47.

Balla, W., Essadki, A. H., Gourich, B., Dassaa, A., Chenik, H., & Azzi, M. (2010). Electrocoagulation/electroflotation of reactive, disperse and mixture dyes in an external-loop airlift reactor. *Journal of Hazardous Materials*, *184*(1–3), 710–716. https://doi.org/10.1016/j.jhazmat.2010.08.097

Butler, E., Hung, Y., Yeh, R. Y., Suleiman, M., & Ahmad, A. (2011). Electrocoagulation in Wastewater Treatment, 495–525. https://doi.org/10.3390/w3020495

Chen, G., Chen, X., & Yue, P. L. (2000). Electrocoagulation and Electroflotation of Restaurant Wastewater. *Journal of Environmental Engineering*, *126*(9), 858–863. https://doi.org/10.1061/(ASCE)0733-9372(2000)126:9(858)

Daneshvar, N., Ashassi Sorkhabi, H., & Kasiri, M. B. (2004). Decolorization of dye solution containing Acid Red 14 by electrocoagulation with a comparative investigation of different electrode connections. *Journal of Hazardous Materials*, *112*(1–2), 55–62. https://doi.org/10.1016/j.jhazmat.2004.03.021

Deepali, & Joshi, N. (2014). Problems of ground water contamination with focus on water borne diseases , causes and prevention. *Applied Science Reports*, *5*(1), 34–41. https://doi.org/10.15192/PSCP.ASR.2014.1.1.3431

Dennett, K. E., Amirtharajah, A., Moran, T. F., & Gould, J. P. (1996). Coagulation :, (C), 129–142. https://doi.org/10.1002/j.1551-8833.1996.tb06539.x

Dura, A. (2013). Electrocoagulation for Water Treatment : the Removal of Pollutants using Aluminium Alloys , Stainless Steels and Iron Anodes Table of Contents, (August).

Guohua Chen, Xueming Chen, and P. L. Y. (2000). E Lectrocoagulation and E Lectroflotation. *Manager*, *126*(September), 3–8.

HACH. (2014). Chemical oxygen demand. *Hach*, *DOC316.53.*, 10. https://doi.org/10.1002/9780470114735.hawley03365

Hammer, D. A., & Bastian, R. K. (1989). Wetlands Ecosystems - Natural Water Purifiers. *Constructed Wetlands for Wastewater Treatment*, 5–19.

Jamil, H. B. M. (2005). Experimental Study on the Factor Affecting Coagulation and Flocculation, 1–24.

Janpoor, F., Torabian, A., & Khatibikamal, V. (2011). Treatment of laundry waste-water by electrocoagulation, (86), 1113–1120. https://doi.org/10.1002/jctb.2625

Khandegar, V., & Saroha, A. K. (2013). Electrocoagulation for the treatment of textile industry effluent - A review. *Journal of Environmental Management*, *128*, 949–963. https://doi.org/10.1016/j.jenvman.2013.06.043

Kobya, M., Can, O. T., & Bayramoglu, M. (2003). Treatment of textile wastewaters by

electrocoagulation using iron and aluminum electrodes. *Journal of Hazardous Materials*, *100*(1–3), 163–178. https://doi.org/10.1016/S0304-3894(03)00102-X

Kuokkanen, V., Kuokkanen, T., Rämö, J., & Lassi, U. (2013). Recent Applications of Electrocoagulation in Treatment of Water and Wastewater—A Review. *Green and Sustainable Chemistry*, *03*(02), 89–121. https://doi.org/10.4236/gsc.2013.32013

Lee, C. S., Robinson, J., & Chong, M. F. (2014). A review on application of flocculants in wastewater treatment. *Process Safety and Environmental Protection*. https://doi.org/10.1016/j.psep.2014.04.010

Murthy, Z. V. P., Nancy, C., & Kant, A. (2007). Separation of pollutants from restaurant wastewater by electrocoagulation. *Separation Science and Technology*, *42*(4), 819–833. https://doi.org/10.1080/01496390601120557

Nakajima, F., Izu, K., & Yamamoto, K. (2001). *Advances in Water and Wastewater Treatment Technology*. *Advances in Water and Wastewater Treatment Technology*. https://doi.org/10.1016/B978-044450563-7/50209-2

Nasrullah, M., Singh, L., Mohamad, Z., Norsita, S., Krishnan, S., Wahida, N., & Zularisam, A. W. (2017). Treatment of palm oil mill effluent by electrocoagulation with presence of hydrogen peroxide as oxidizing agent and polialuminum chloride as coagulant-aid. *Water Resources and Industry*, *17*(October 2016), 7–10. https://doi.org/10.1016/j.wri.2016.11.001

Omwene, P. I., & Kobya, M. (2018). Treatment of domestic wastewater phosphate by electrocoagulation using Fe and Al electrodes: A comparative study. *Process Safety and Environmental Protection*, *116*, 34–51. https://doi.org/10.1016/j.psep.2018.01.005

Pernitsky, D. J., & Edzwald, J. K. (2006). Selection of alum and polyaluminum coagulants: Principles and applications. *Journal of Water Supply: Research and Technology - AQUA*, *55*(2), 121–141. https://doi.org/10.2166/aqua.2006.062

Phalakornkule, C., Polgumhang, S., & Tongdaung, W. (2009). Performance of an Electrocoagulation Process in Treating Direct Dye : Batch and Continuous Upflow Processes, 277–282.

Prashant Basavaraj Bhagawati, C. B. S., & Department. (2017). Separation of pollutants from pulp mill wastewater by electrocoagulation, *13*, 166–176.

Semerjian, L., & Ayoub, G. M. (2003). High-pH-magnesium coagulation-flocculation in wastewater treatment. *Advances in Environmental Research*, *7*(2), 389–403. https://doi.org/10.1016/S1093-0191(02)00009-6

Sharom, N. B. (2012). Mercury Removal From Wastewater By Electrocoagulation, (January).

Song, S., Yao, J., He, Z., Qiu, J., & Chen, J. (2008). Effect of operational parameters on the decolorization of C . I . Reactive Blue 19 in aqueous solution by ozone-enhanced electrocoagulation, *152*, 204–210. https://doi.org/10.1016/j.jhazmat.2007.06.104

Thite, M., & Chaudhari, P. K. (2015). Electrocoagulation of Waste Water and Treatment of Rice Mill Waste Water : A Review. *International Journal of Science and Research*, *4*(9), 233–239.

Treatment, W., Small, P., & Life, C. (1996). Wastewater Treatment Protects Small Community Life, Health, *7*(3), 1–8.

Tripathy, T., & De, B. R. (2006). Flocculation: A new way to treat the waste water. *Journal of Physical Sciences*, *10*(January 2006), 93–127.

Van Overbeek, L. S., Van Doorn, J., Wichers, J. H., Van Amerongen, A., Van Roermund, H. J. W., & Willemsen, P. T. J. (2014). The arable ecosystem as

battleground for emergence of new human pathogens. *Frontiers in Microbiology*. https://doi.org/10.3389/fmicb.2014.00104

Vasudevan, S., Lakshmi, J., & Sozhan, G. (2011). Effects of alternating and direct current in electrocoagulation process on the removal of cadmium from water. *Journal of Hazardous Materials*, *192*(1), 26–34. https://doi.org/10.1016/j.jhazmat.2011.04.081

Verma, A. K. (2017). Treatment of textile wastewaters by electrocoagulation employing Fe-Al composite electrode. *Journal of Water Process Engineering*, *20*(November), 168–172. https://doi.org/10.1016/j.jwpe.2017.11.001

Verma, A. K., & Rajesh Roshan Dash. (2012). A review on chemical coagulation/flocculation technologies for removal of colour from textile wastewaters. *Journal of Environmental Management*, *93*(1), 154–168. https://doi.org/10.1016/j.jenvman.2011.09.012

Winter, P.-. (1996). Small Community Wastewater Issues Explained to the Public. *National Small Flows - Clearinghouse*, *7*(1), 8.

Xu, X., & Zhu, X. (2004). Treatment of refectory oily wastewater by electro-coagulation process. *Chemosphere*, *56*(10), 889–894. https://doi.org/10.1016/j.chemosphere.2004.05.003